

**UNIVERSITY OF VAASA**  
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**DO STOCKS ADDED TO A STOCK INDEX OUTPERFORM THOSE THEY  
REPLACE? EVIDENCE FROM CHANGES TO THE FRENCH CAC 40 INDEX  
BETWEEN 1993 AND 2009**

Master's Thesis in Accounting and Finance  
Finance

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**ABSTRACT**

This study examines whether stocks deleted from the CAC 40 Parisian blue-chip index between 1993 and 2009 outperformed stocks added to the index. Two approaches are followed to answer this question. First, two portfolios are formed, one consisting of all stocks added to the index and one consisting of all stock deleted from the index between 1993 and 2009. The substituted stocks are added to their respective portfolios 10 days after the announcement is made. Daily returns and daily adjusted returns are calculated. The results show that the deleted stock portfolio outperformed both the added stock portfolio and the market by 0.013% and 0.012% respectively per day. Risk adjusted performance ratios indicate that the higher return is not merely a compensation for higher risk. Nevertheless, it appears that the results cannot be generalised perhaps due to too small a sample. The second approach looks at the added and deleted stocks' average performance at different intervals after announcement of their addition to or removal from the CAC 40 is made. The results indicate that deleted stocks outperformed added stocks over the first five years after substitution. Deleted stocks showed an average increase in value of 4.1% compared to an average loss of 2.69% for added stocks one year after replacement was announced. After five years, deleted stocks' value increased on average by 53.5% while added stocks increased on average by 35.9%. Theoretically, the well researched phenomenon of regression towards the mean in stock prices as well as biased index rules may explain these results.

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**KEYWORDS:** Regression towards the mean, Index Rebalancing, Investment Strategy, Contrarian Strategy, Winner Loser Effect



## 1. INTRODUCTION

This study examines whether stocks deleted from the CAC 40 Parisian blue-chip index between 1993 and 2009 outperformed stocks added to the index.

A stock index provides investors with a snapshot of the evolution of the values which constitute it. These constitutive elements can for instance be companies listed on the same exchange (Topix in Japan), on the same continent (MSCI North America), which belong to the same industry (MSCI Europe Energy) or which have similar market capitalizations (Russel 2000). It is a widely held assumption among practitioners that stock indexes are neutral investment decisions and give for instance a representation of a country's listed companies or in short of "the market". Thus, stock indexes are used as benchmarks to measure the performance of actively managed portfolios whose goal is usually to beat their index and, by doing so, justifies the fees associated with holding them.

Stock indexes are also at the centre of the thriving development of "passive investing" through such instruments as index funds and more recently ETFs. According to the national association of U.S. investment companies, the net assets invested in index funds increased 21 folds since 1993 to reach USD 604 billion in the US only at the end of 2008. *The Economist* (2011) also reports "exchange traded funds had almost \$1.5 trillion of assets under management which correspond to an average annual growth rate of 34% over 10 years". There are two main reasons for their rapid development. On the one hand, fees charged to investors are lower than for actively managed funds. On the other hand, research has found that active funds do not outperform passive funds once the fees are accounted for. For instance, Carhart (1997) reports that nearly 1,500 U.S. mutual funds underperformed their benchmark every other year between 1962 and 1992. Moreover, funds that beat their index in the past tend not to beat it again in the future. (cf. Grinblatt and Titman 1989, Kazemi, Schneeweis & Pancholi 2003).



There are different categories of stock indexes. One way to differentiate between them is to look at whether their composition is inclusive or exclusive. Indeed a stock index is not a static benchmark; it requires periodical rebalancing in order to keep in line with its objective. Companies are added to or deleted from inclusive indexes according to a set of quantitative and measurable rules (USA's 3,000 largest listed companies by market capitalisation for the Russel 3000 for instance). In this case, the addition or deletion of a company is neither left to the discretion of a committee nor does it directly depend on its relative over or underperformance. As such, inclusive indexes seem to be better candidates for neutral investment decisions. However, the world's most renowned and benchmarked stock indexes tend to be exclusive which means that their composition is decided by a steering committee responsible for the periodical review and selection of their constitutive elements.

The French CAC 40 on which this thesis is based is an exclusive index. It tracks a sample of 40 blue-chip companies thought to be representative of the Parisian equity market and selected among the one hundred largest market capitalisation and most traded stocks listed on Euronext Paris. The index's composition is reviewed by the "Conseil Scientifique" every quarter, though changes do not necessarily take place. Besides quantitative data such as market capitalisation and liquidity, the quality of representing the Parisian equity market is left to the discretion of the steering committee. The DJIA, S&P 500, FTSE 100, Nikkei 225, Dax 30 are other famous examples of exclusive indexes.

Stock indexes are officially tied to very strict and objective rules as to why a stock should be added to or deleted from the index. These rules are in theory independent of stocks' performances. *However, Ranaldo and Häberle (2008: 55) have found that "any passive investment tracking these indexes turns into an active strategy characterised by market timing and state dependent performance and that market indexes imply forms of active investment management in disguise"*. Given the critical and growing impact of stock index performances on investors' wealth, I find it important to understand how stocks perform after they are added to or deleted from an exclusive index. However, and quite

surprisingly in my opinion, almost all of the research looking into the impact of index rebalancing focuses on short term stock prices and volatility in the aftermath of the substitution announcement and almost never on the long term behaviour of the replaced stocks.

The results of this thesis are important because it is aiming at filling several gaps. They will further knowledge in a topic that has been left rather undocumented until now, they will help investors anticipate how stocks are likely to perform after they are added or deleted from an exclusive index thus perhaps creating a new contrarian investment strategy, they will help stock indexers be aware of potential selection bias in their index rules, and finally it is to my knowledge the first study of its kind to focus on a European index.

## **1.1. Research problem and hypotheses**

### **Problem statement:**

*Do stocks added to the CAC 40 stock index outperform those they replace?*

### **Hypotheses:**

The first and most prominent hypothesis of this study is that there exists a phenomenon of regression to the mean in equity markets. *Balvers, Wu and Gilliland* (2000: 745) define mean reversion as “a tendency of asset prices to return to a trend path”. The authors found strong evidence of mean reversion in the MSCI index which includes 18 countries with mature financial markets. Mean reversion suggests that firms that have been performing exceptionally well in the recent past are bound to lower performance in the future because they are likely to have been performing above their long term trend and capabilities. The reverse is also true for companies that have been performing poorly.

H<sub>1</sub>: There exists a phenomenon of regression to the mean in the stock market.

Ranaldo and Häberle (2007) studied the constitution and rebalancing rules of several of the world's most commonly benchmarked active stock indexes. Their work showed how false an assumption it would be to consider a form of passive investment investments strategies replicating the performance of such indexes. *Ranaldo and Häberle (2007: 55) concluded "the constitution and maintenance rules of exclusive indexes correspond to a set of active trading and investment rules similar to momentum strategies"*.

H<sub>2</sub>: Active stock index rules lead to the addition of the recent past's best performing and the deletion of the recent past's worst performing stocks to the index.

The founding and still central paper of investors' psychology were published in the early 1970s. Kahneman and Tversky (1974) posited that regression to the mean is often misunderstood, insufficiently appreciated or ignored even when bound to happen. The two psychologists designed experiments which attempted to measure how rational individuals are in assessing the likelihood of certain events. *The results showed that "people fail to "regress" or move to predicting the mean even when the input data is stated to be highly unreliable". (Kahneman and Tversky 1973: 237.) What is more, the fact of ascribing cause to for instance increasing stock prices where none exist because the natural regression towards the mean is ignored is in the words of Milton Friedman (1992: 2131) "the most common fallacy in the statistical analysis of economic data"*.

H<sub>3</sub>: Steering committees in charge of index composition largely ignore the tendency of stock prices to regress to their long term trend.

By extrapolating from these three hypotheses, I am able to formulate a fourth which will be the one tested in this thesis. Stocks deleted from an index may have been performing below their long term ability while stocks added to an index may have been performing above that ability for some time. As they regress to their long term ability however,

deleted stocks may outperform added stocks. This tendency may largely be ignored by steering committees either due to the regression fallacy or due to index rules enabling this pattern.

H<sub>4</sub>: On the long run, stocks removed from the CAC 40 index may outperform the stocks replacing them as their performance regress to their long term trend.

The two following hypotheses are not central to my thesis but enable me to adjust the methodology for some known market phenomena which may have an impact on the findings. I believe that this will improve the robustness of the results as well as better fit the logic behind my research question.

Initiated by two studies by Shleifer (1986) and Harris and Gruel (1986), the periods surrounding an individual stock's addition or deletion from an index have been since then thoroughly documented in the literature. Numerous studies of different indexes across the world have led to a widely accepted conclusion about a symmetric price effect with addition to an index leading to a price increase and deletion from an index leading to a price decrease as passive mutual funds managers readjust their holdings to match their target index and speculators try to anticipate and take advantage of stock replacements. The studies have found that abnormal returns and volume activity occur around the day of the announcement. The debate is about whether this price pressure is permanent as supported by Denis, McConnell, Ovtchinnikov and Yu (2003) or only temporary as supported by Shankar and Miller (2006). With regards to the CAC 40 index, Vespro (2006) finds evidence supporting the price pressure hypothesis over the time period 1997 – 2001. In other words there seems to be only a temporary rise in the stock price and trading volume of the added security and a temporary fall in the stock price and trading volume of the deleted security.

H<sub>5</sub>: Temporary abnormal market activities occur around the addition or deletion of a stock from the CAC 40 index.

Substantial evidence collected from various markets across the world has shown that initial public offerings (IPOs) traditionally exhibit three patterns: under pricing, "hot issue" markets (periods of high average initial returns and rising volume) and poor long term performance. The latter is the pattern of interest for this study. In France, Leleux (1993) investigated the performance of IPOs in the 48 months following their introduction on the Paris Secondary Market (now CAC mid 100); a Mid-cap index. *He found that "an equal-amount investment in all IPO shares at the beginning of the first complete month of secondary trade would have earned investors an abnormal - 11.2 % rate of return over three years".* (Leleux 1993:106.)

H<sub>6</sub>: IPO stocks underperform the market in the long-run and drag down the performance of the Addition portfolio.

## 1.2. Review of earlier literature

The pioneering studies of Shleifer (1986) and Harris and Gruel (1986) initiated an extensive literature on the effects of index rebalancing. The days and weeks surrounding an individual stock's addition or deletion from an index have been since then thoroughly documented in the literature. The same conclusions have been drawn in most cases about the events occurring in the aftermath of the announcement and led to a widely accepted consensus about a symmetric price effect, addition incurs price increase and deletion incurs price decrease. There is, however, still a debate as to whether this price pressure is permanent or only temporary.

Harris and Gurel (1986) report a significant price increase of 3% after a stock is added to the S&P 500. However, they also find that the price increase is nearly fully reverted two weeks after the addition. Other studies did not focus on a large-cap index and still found similar results. Shankar and Miller (2006) find that firms added to the S&P small cap index experience a price increase at announcement which is fully reverted 60 days after

inclusion. These results support the temporary price pressure hypothesis which states that long-run demand curves are perfectly elastic but can be temporarily shifted. Indeed, index fund managers must buy stocks added to an index and sell stocks removed from it. With such large institutions all making the same move at the same time, abnormal price pressures must occur.

On the contrary, Shleifer (1986) find that the price increase experienced by a stock is still persistent at least 20 days after its inclusion in the S&P 500. More recently, Lynch and Mendenhall (1997) provide new evidence on stock price effects associated with changes in the S&P 500 index. For the additions, the authors find a significant positive cumulative abnormal return from the day after the announcement until the day before the effective change; while prices only partly revert on and after the effective date of the inclusion. The reverse holds true for deletions as well. A persisting effect on prices even after the announcement date is consistent with the hypothesis of downward sloping demand curves (also known as imperfect substitute hypothesis). Denis et al. (2003) also report a permanent price increase after a stock is added to the S&P 500 index. But unlike previous research, they do not consider a stock addition to an index to be an information-free event. Indeed, they document that newly included companies experience significant increases in earnings per share forecasts and realized earnings. These two elements in turn explain why newly added stocks experience a permanent price increase.

Finally, Chen, Noronha and Singal (2006) reported that firms added to the S&P 500 experience a permanent price increase whereas firms deleted from the index suffer only a temporary price decline. Investor's awareness is proposed as an explanation for the asymmetric price response as investors become more aware of a stock added to the index but do not become less aware of a stock deleted from the index.

Even though most attention has been given to US stock indexes, a few studies have used stock indexes elsewhere as benchmarks. Vespro (2006) uses three European indexes in her studies; London's FTSE 100 and Paris' CAC 40 and SBF 120 indexes. Her results

support the temporary price pressure hypothesis underlining the fact that once the index fund's adjustment process ends, prices regress to their pre-announcement levels.

The short-term effects of index rebalancing on individual stocks have been fairly well documented. In contrast, only little attention has been given to the effects of stock replacements on the overall index's long-term performance. Arora, Carp and Smith (2006) showed that a portfolio consisting of all stocks removed from the Dow Jones Industrial Average since 1929 outperformed a portfolio consisting of all added stocks. They explain this result by the market's insufficient consideration of the mean reversion phenomenon. Looking at a similar issue but from a slightly different angle, Siegel and Schwartz (2006) found that the companies chosen for the original S&P 500 in 1957 have yielded higher returns at a lower risk than the continually updated index. In a recent paper, Cai and Houge (2008) showed that a buy-and-hold portfolio strategy would have significantly outperformed the rebalanced Russel 2000 small-cap from 1974 to 2004 index by 2.22 % a year and by 17.29 % over five years. The results outlined the index additions' poor long-term returns relative to that of the index deletions.

Interestingly, the results are consistent with studies assessing the efficacy of contrarian strategies such as the winner-loser effect based on stock's recent performance (in lieu of addition to or deletion from an index). Balvers et al. (2000) demonstrate that holding the worst performing stocks of the past three years and short selling the best performing stocks of the past three years outperforms other investment strategies such as buy-and-hold. Richard (1995, 1997), Narasimhan and Titman (1993) and De Bondt and Thaler (1985) had applied similar strategies and found similar results. Most recently, Rinne and Vähämaa (2011) found this strategy to yield superior results in Europe as well.

### **1.3. Structure of the study**

This thesis consists of 5 chapters. Chapter two provides the theoretical background for this study. It describes at length the phenomenon of regression towards the mean, the different theories that support it and the effects of its working on exclusive stock indexes. Chapter three presents the data used for the purpose of this study and the methodology followed to answer the research problem. Chapter four presents and analyzes the results. Finally chapter five presents the conclusions of this thesis and suggests some avenues for further related research.



## 2. THE PHENOMENON OF REGRESSION TOWARDS THE MEAN

Although regression towards the mean is a rather straightforward concept and is reckoned with in social and medical sciences, its existence and origin in stock markets remains unclear and debated.

### 2.1. General description of the statistical phenomenon

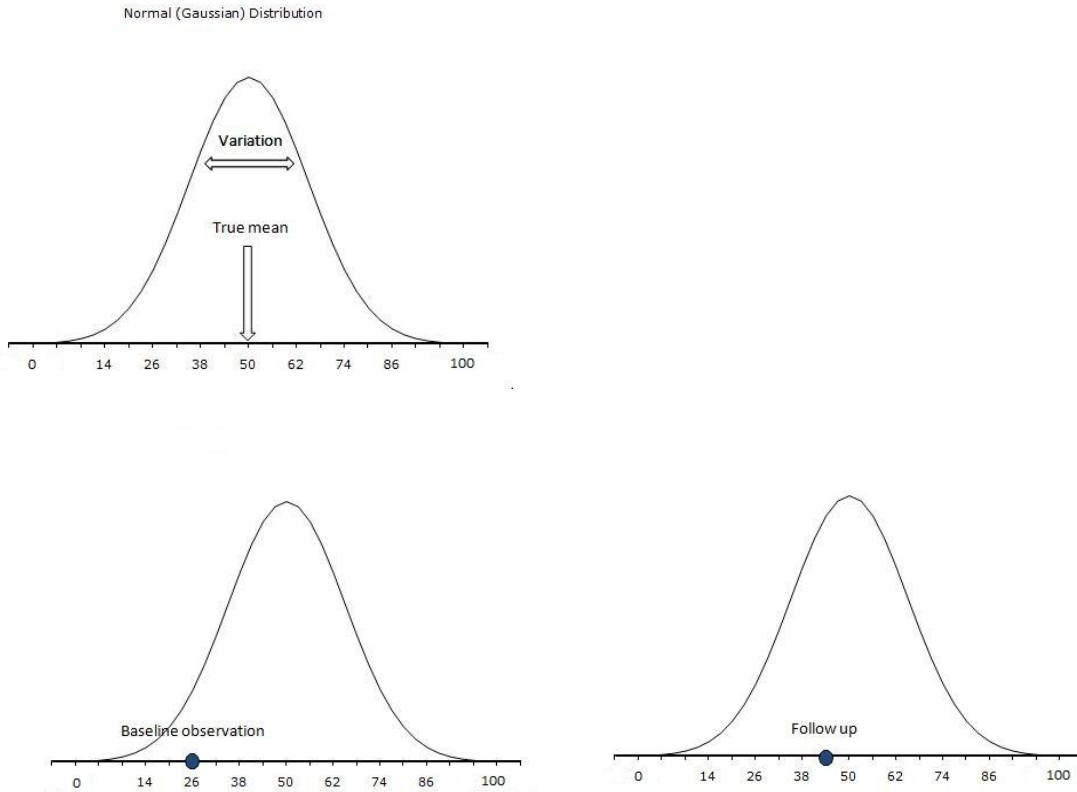
The phenomenon of regression towards the mean was discovered and first described by Sir Francis Galton in 1869 when he stated that descendants of the most illustrious statesmen, musicians, scientists, painters and other outstanding people tend to be less talented than their eminent ancestors. Though his work approached regression towards the mean, he was unable to formally theorize it until 1889 when he studied a measurable quality; height. Galton examined the heights of fathers and sons and discovered that the sons of exceptionally tall fathers tend to be shorter than their fathers whereas sons of exceptionally short fathers tend to be taller. *Galton (1889: 95) concluded “however paradoxical it may appear at first sight, it is theoretically a necessary fact, and one that is clearly confirmed by observation, that the Stature of the adult offspring must on the whole, be more mediocre than the stature of their Parents, that is to say, more near to the mean or mid of the general population”*. Thus, the concept of regression towards the mean expresses the fact that if a variable is extreme on its first measurement, it will tend to be closer to the average on a second measurement.

Assuming variables  $x$  and  $y$  have standard deviations  $S_x$  and  $S_y$  and correlation coefficient  $r$  comprised between -1 and 1 (i.e. are not perfectly correlated); the definition of regression towards the mean in mathematical terms can be expressed as follows:

$$(1) \quad \frac{rS_y}{S_x}$$

Thus a change of one standard deviation in  $x$  is associated with a change of  $r$  standard deviations in  $y$ . For a given value of  $x$ , the predicted value of  $y$  is always fewer standard deviations from its mean than is  $x$  from its mean. The data point exhibits regression towards the mean unless  $x$  and  $y$  are perfectly correlated. Subsequent work showed that regression towards the mean is not restricted to simple linear regressions of data points, it also occurs in cases where random variables follow a normal distribution or in other words have an identical marginal distribution with a mean.

A common and simple example is to consider a class of students taking a 100 question true / false test. If all the students reply randomly to the questions then each score would be a realization of one of a set of independent and equally distributed random variables with a mean of 50. This is expressed in Figure 1 in which the distribution represents test scores on a single subject with a true mean of 50. Due to chance some students will score well above 50 while due to bad luck some others will score well below 50. In real life, students' scores at true / false tests is often a combination of skills and luck. The best performers will be those who have combined skills and were not especially unlucky and those who were unskilled but were especially lucky whereas the worst performers will be those who have combined lack of skills and were not especially lucky and those who were skilled but were especially unlucky. After the first test, if a group comprising the best performers and a group comprising the worst performers are formed and students are asked to take a second true / false test, the best performers are likely to achieve a lower score while the worst performers are likely to achieve a higher score. The reason being that those who were especially lucky at the first test are unlikely to repeat their luck while those who were especially unlucky at the first test are more likely to be luckier. The aggregated effect is scores regressing to the mean.



**Figure 1.** Graphical example of true mean, variation and regression to the mean using a normal distribution.

To summarize, observed scores fluctuate around a “true score” attributable to skills to which is added or subtracted a temporary mean reverting “error score” which can be attributed to the luck or bad luck component. Kaplan and Saccuzzo (2008) express it as follows:

$$(2) \quad X = T + \varepsilon$$

Where  $X$  is the observed score,  $T$  is the true score and  $\varepsilon$  is the identically distributed error term. The different values of  $\varepsilon$  are uncorrelated.

Evidence of regression towards the mean has been documented in numerous fields with

important ramifications. In baseball, Schall and Smith (2000) found that batting averages and earned run averages regress towards the mean and therefore predictions can be improved substantially by shrinking performances towards the mean. Perhaps more importantly, in medical studies the practical problem caused by regression to the mean is to distinguish real change from expected natural variation. For instance, when considering a subject's increased cholesterol level, physicians have to wonder whether it was not unusually low when measured the first time and is now not simply regressing to its "true score". In social sciences and in drug testing, the understanding of regression to the mean has led to the introduction of control groups to separate the effect of treatments from the statistical effect of regression towards the mean (cf. Barneu, Van der Pols and Dobson, 2004: 218). For instance, patients with extremely high blood pressure may be treated to bring their values closer to healthier levels. If they are measured again, physicians will observe that the mean of the extreme group is now closer to the mean of the whole population. Without control group however, this should not be interpreted as showing the positive effect of the treatment since even if subjects were not treated the mean blood pressure would have gone down owing to the effects of regression towards the mean.

There is also evidence of regression towards the mean in finance. Regression towards the mean implies for instance that companies exhibiting exceptionally low profitability (relative to their "true score" or true ability) for some time are bound to experiencing higher profitability in the future whereas companies exhibiting exceptionally high profitability (relative to their "true score" or true ability) for some time are bound to experiencing lower profitability in the future. *Fama and French (2000: 161) investigated this issue and found "strong evidence that profitability (measured as the ratio of year  $t$  earnings before interest to total book assets,  $Y_t/A_t$ ) is mean reverting"*. In the same vein, regression towards the mean would imply that, as for baseball players, the best prediction of a firm's earning is the mean earning prediction. *Keil, Smith and Smith (2004: 943) say:*

*"persuasive evidence is found that relative earnings forecasts are systematically too extreme – too optimistic for companies predicted to do well and too pessimistic for those predicted to do poorly. The accuracy of these forecasts can be improved consistently and substantially by shrinking them towards the mean".*

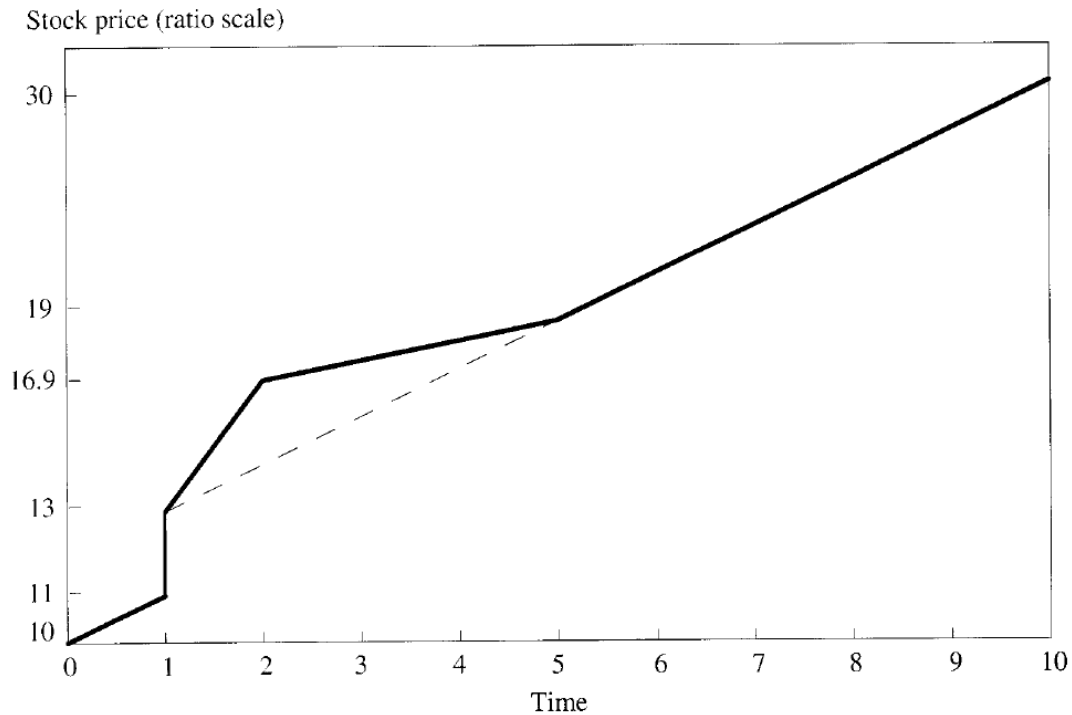
Dorsey-Palmateera and Smith (2007) found similar results with predicting the level of T-bills, T-bonds and corporate bonds.

## **2.2. Regression towards the mean in stock markets**

Researchers also looked for evidence of regression towards the mean in stock markets. Despite numerous papers investigating the issue, it is still very much open to debate. For every paper supporting the view that stock prices or stock markets are mean reverting, there is another paper contradicting the results or casting doubt on the models used. The theoretical framework of regression towards the mean in stock prices implies that, in the same manner as for test scores, stock prices are the sum of a permanent component influenced by fundamental factors (the “true score”) which follows a random walk and a temporary mean reverting component. The reason for researchers’ interest in findings evidence of a mean reverting component in stock prices stems from the fact that it would imply some degree of predictability over long horizons. Several strategies have been used to demonstrate the mean reverting character of stock prices.

### **2.2.1. Evidence of mean reversion in stock prices**

In an efficient market, stock prices are supposed to rise at a constant rate and past returns should give no indication whatsoever about future returns. In other words, in a regression of stock returns on a constant term and past returns, the constant term should be positive but the slope coefficient on past returns should be zero. To the contrary, if returns are mean reverting, the slope should be negative as periods of abnormally high returns are followed by periods of abnormally low returns. Figure 2 shows the behavior of stock prices in an efficient market and how it differs from the behavior of stock prices in an inefficient market.



**Figure 2.** Stock prices in an inefficient market. (Source: Engel and Morris 1991)

In the example above taken from Engel and Morris (1991:25), a company's stock price jumps as it announces higher dividends will be paid out. Because the return over the first period is 30% instead of 10%, feedback traders buy the stock thus pushing the price above its fundamental value (represented by the dashed line). Value traders will then begin selling the overvalued stock putting downward pressure on its price and causing the return to fall over the next few periods. Feedback traders are also likely to begin selling the stock following periods of low returns adding downward pressure on the stock price as in a self fulfilling prophecy. Eventually the price returns to its fundamental value after a period of abnormally high returns followed by a period of abnormally low returns.

Early tests of market efficiency focused on daily and monthly returns and found the slope to be very close to zero. Researchers therefore concluded that markets were efficient. In

retrospect however, the results are not surprising as regression towards the mean is thought to take place over long horizons. Fama and French (1988) are among the first to run regression tests over several decades to find out if returns become negatively correlated as the holding period increases. They took on to examining monthly returns for holding periods of between one and five years for all stocks listed on the New York Stock Exchange over the period 1926 – 1985 expecting to find significant negative autocorrelations for longer holding periods thereby showing that stock prices are at least partly predictable. In accordance with the efficient market theory and with previous work, holding periods of less than a year do not exhibit mean reversion. Autocorrelations become negative after two years and reach a low for holding periods of three to five years. The authors found that an astonishing 35% of stock returns are predictable. Beyond five years, the autocorrelations become positive again implying that the random walk component of the price eventually takes over the variation of returns. The authors also found mean reversion to be stronger for smaller firms. Finally, it seems that most of the predictability is due to the earlier data. *Fama and French (1988: 266) conclude:*

*“stationary price components may be less important after 1940, or perhaps prices no longer have such temporary components. Resolution of this issue will require more powerful statistical techniques”.*

### **2.2.2. Evidence of mean reversion in volatility**

In both efficient and inefficient markets, stock prices are volatile because they react to new information. In the long run, volatility is the same whether prices are mean reverting or not. However, in inefficient markets, short term volatility is higher than in efficient markets because investors react irrationally to new information. Poterba and Summers (1988) demonstrate that if stock prices indeed followed a random walk, the variance of stock returns should be proportional to the return horizon and short term volatility should not be any higher than long term volatility. In other words, if markets were efficient, the variance of  $n$ -year returns ( $r_n$ ) should equal  $n$  times the variance of annual returns ( $r_1$ ). To the contrary, if returns are mean reverting, the ratio should fall below zero.

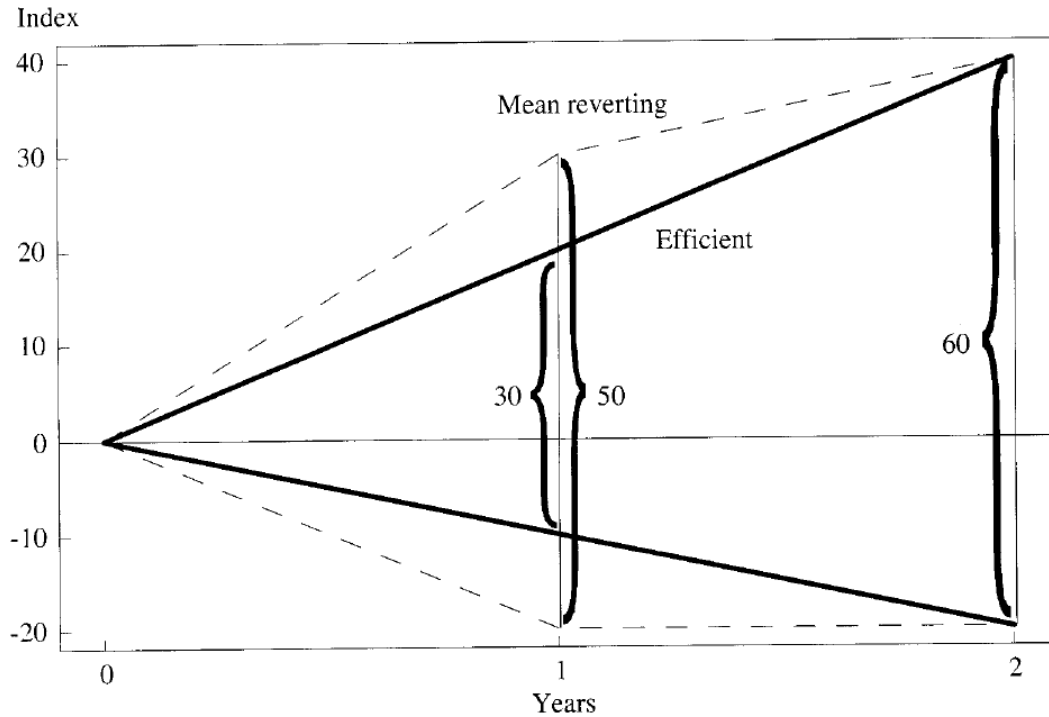
$$(3) \text{ Variance } (r_n) = n \times \text{Variance } (r_1)$$

Or

$$(4) \text{ Variance } (r_n) / (k \times \text{Variance } (r_1)) = 1$$

Figure 3 gives an example taken from Engel and Morris (1991:27). In an efficient market, if a stock's price can either rise 20% or fall 10% a year (represented by the solid lines), then for a two-year investment, the best possible return is 40% and the worst a negative 20%, leading to a volatility of 60%. If prices are mean reverting however, because they deviate from their fundamental value in the short term but not in the long term they might for instance rise by 30% or fall 20% (represented by the dashed lines) the first year (volatility is 50%) before returning to its fundamental value. In this case, the volatility over the second year would have to be much lower than over the first year.





**Figure 3.** Investment risk in an inefficient market. (Source: Engel and Morris 1991)

To investigate mean reversion in stock prices by looking at returns volatility, Poterba and Summers (1988) looked at the variability of monthly returns on the New York Stock Exchange between 1926 and 1985 as well as in several markets outside the US over increasing holding periods. The aggregated results show that for holding periods of between two and eight years, return variance increases less than proportionally with time implying that the temporary mean reverting component accounts for a part of the variance in returns. *However, the robustness of the findings is weak and the authors conclude “although individual data sets do not consistently permit rejections of the random-walk hypothesis at high significance levels, the various data sets together strengthen the case against its validity”.* (Poterba and Summers 1988: 59.)

### 2.2.3. Evidence of mean reversion in multivariate time series

The evidence to support regression towards the mean being somewhat weak when looking only at returns and volatility, researchers started to use multivariate time series analysis to identify permanent and temporary components in stock prices. For instance, Cochrane (1994) examines annual changes in stock prices together with annual changes in dividends between 1927 and 1988 while Lee (1995) looks at stock price-dividend spreads and real stock prices over the 1926 – 1991 period. Both studies report a sizeable mean reverting component in stock prices. The international evidence supports the case for the existence of a mean reverting component in stock prices. Gallagher (1999) identifies the temporary and permanent components of real stock prices analyzing real stock returns and inflation. Using quarterly data for 16 countries between 1957 and 1995, the author finds the temporary mean reverting component to explain between 7 and 64% of the variation in real stock returns depending on the country. The majority of these studies have examined the dividend-price ratio as a forecasting factor of stock returns. A few have also considered aggregate business or macroeconomics factors. Gallagher and Taylor (2002) estimate the mean reverting component of US stock prices using inflation, interest rates, output, the wage rate and consumption between 1949 and 1997. The authors found that monthly US real stock prices reveal a mean reverting component accounting for 42% of the stock price variation.

#### **2.2.4. Evidence of mean reversion in stock indexes**

As shown earlier, regression towards the mean takes place at both individual and group level in social and medical sciences. In the same manner, given that evidence of regression towards the mean is found in stock prices it is likely to be found in stock market indexes as well. However, few studies have looked for evidence of regression towards the mean at an aggregated level. *Of them was conducted by Balvers et al. (2000: 745) who define mean reversion as “a tendency of asset prices to return to a trend path”.* The authors compared annual returns on 18 stock indexes of countries with mature financial markets between 1969 and 1996 with returns on a reference index; the Morgan Stanley Capital International (MSCI) world index which includes, among others, the 18

countries under investigation. The results support the assumption that stock indexes are mean reverting relative to a reference index. The authors found the phenomenon to have a half life span of between 3 and 3.5 years.

### **2.2.5. Evidence against the existence of regression to the mean**

Despite the evidence mentioned above and although I assume in this thesis that stock prices are mean reverting (hypothesis 1), it is worth mentioning that the academic world has not yet come to an agreement.

Common critics of papers claiming to have found evidence of regression towards the mean in stock markets include:

- Most studies are based on small samples of non-overlapping time series. For instance in Fama and French (1988), there are only 12 independent observations of five-year returns (60 years divided by five).
- Mean reversion disappears if pre-war data are not taken into account. This was already noticed by Fama and French (1988: 266). Kim and Nelson (1997) examined data from the NYSE between 1947 and 1995 and found little evidence of mean reversion.
- The results are based on models which tend to amplify the degree of mean reversion in stock markets (cf. Daniel: 2001). *Richardson* (1993: 201) *explains* “the overall conclusion from this work is that long-horizon *t*-statistics tend to overstate the degree of mean reversion in the data”.
- Perron and Vodounou (2004) and Clark and Coggin (2011) are just two recent examples of recent studies who assert that stock prices follow a random walk and have not found any significant mean reverting component.

The momentum effect has been widely documented in the financial literature. It expresses the fact that shares that have performed well in the recent past continue to do so for some time which, at first sight, seems contradicting the existence of regression towards the mean. Narasimhan and Titman (1993) found that holding for 6 months a portfolio consisting of stocks that have performed well over the past 6 months outperforms a portfolio consisting of stocks that have performed poorly over the past 6 months by about 1% per month. A long term international study was recently undertaken by Dimson, Marsh and Staunton (2008). Using data on the UK's 100 largest stocks between 1900 and 2007, the authors found that buying the 20 best performers and shorting the worst performers over the past 12 months and then rebalancing the portfolio every month produced an annual excess return of 10.3%. Using shorter time-series data from 2001 to 2007, they found similar results in 16 other markets with winners outperforming losers by 4% a year in the US, 21% in France and an astonishing 39% in Germany.

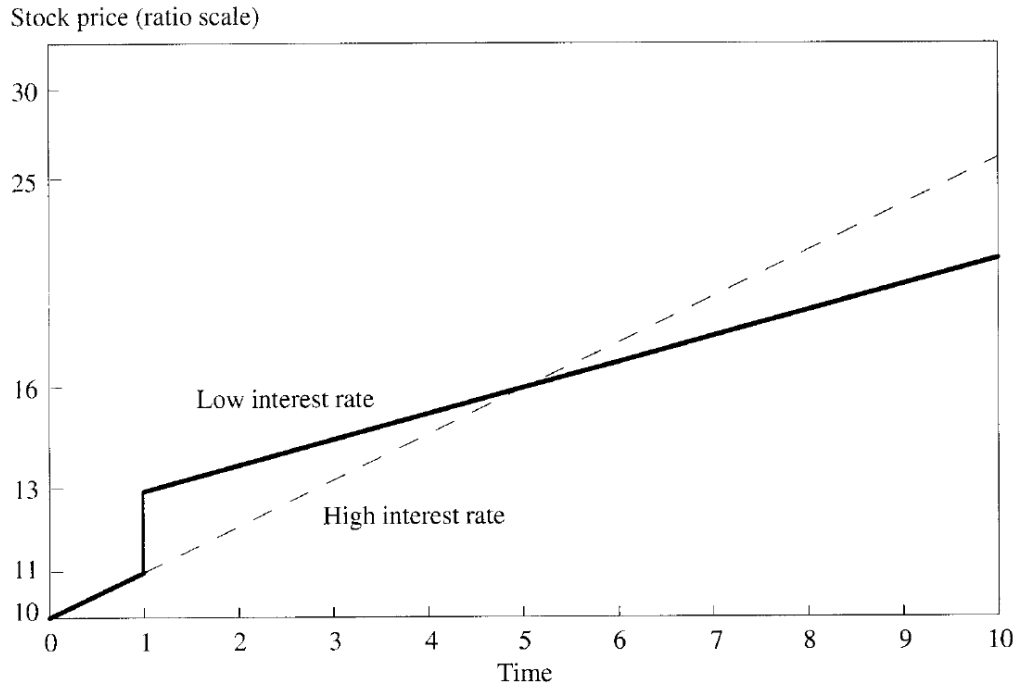
However, momentum in stock prices does not contradict the existence of mean regression. In fact, it seems to constitute the first leg of the phenomenon. Papers reviewed as part of this thesis find evidence of momentum in stock prices over short to medium periods of time (1 to 6 months) while mean regression is found to take place over long periods of time (2 to 5 years).

### **2.3. Regression towards the mean in stock markets and market efficiency**

Proponents of the efficient market theory see in mean regression the workings of more sophisticated equilibrium models. To the contrary, opponents of the efficient market theory see in mean regression the sign of investors' irrationality which is incompatible with efficient markets.

The first theory is supported by Fama and French (1988) and Cecchetti, Lam and Mark (1990) among others. The researchers argue that mean reversion results from the workings of efficient markets and that some degree of predictability in stock returns does not rule out this fundamental theory. Their argument is that expected returns correspond to the discount rates that relate a current stock price to expected future dividends. In the “basic” definition of efficient markets, the expected real returns are assumed to be constant over time because real interest rates are assumed to be constant. However, assuming real interest rates vary in time and are mean reverting, returns should also vary in time and be mean reverting even in an efficient market. The authors describe several scenarios that could contribute to changes in real interest rates. For instance, if investors’ risk aversion and firms’ riskiness changed over time, interest rates and therefore expected returns would vary as well. Thus if interest rates are mean reverting, perhaps due to investors’ smoothing their consumption or because rates fall during recessions and rise during booms, stock prices may appear mean reverting even if the market is efficient. In this case, the mean reverting component in stock prices would become indistinguishable from the temporary price components of an inefficient market.

Again Engel and Morris (1991: 31) provide a good illustration. Suppose that interest rates fall at the end of period one due to a fall in riskless interest rate, in the riskiness of stocks or in investors’ risk aversion. According to the theory of efficient markets, this causes the stock price to rise. At the same time, the lower interest rate implies that future prices will grow at a slower rate. As figure 4 shows, the stock price first jumps above the previous trend and then reverts towards the old trend as if the market was inefficient.



**Figure 4.** Effect of a change in interest rates on stock prices in an efficient market.

(Source: Engel and Morris 1991)

However, many question the paradigm that markets are efficient in the first place. Interestingly, Poterba and Summers (1988) tested by how much annual expected returns would need to vary in order to account for observed levels of mean reversion in their sample. They calculated that the annual standard deviation of expected returns would have to be between 4.4 and 15.8%. Given that rational investors put their money into stocks only if they expect a positive return, the standard deviation of required returns imply that expected returns have to frequently exceed 20% which they judge implausible. *They conclude that "substantial variability in required returns is needed to explain mean reversion in prices" and attribute their results to the fact that markets are inefficient.* (Poterba and Summers 1988: 59.)

As shown by quantity of research done in the field of financial psychology, investors often do not act nor react rationally (cf. De Bondt and Thaler: 1985, Kahneman and

Riepe: 1998, Odean: 1999, Shiller: 2000). *Engels and Morris* (1991: 21) ask "*what information could have possibly caused the profitability of the companies in the Dow Jones Industrial Average to fall 23 percent on October 19, 1987?*" The fact that markets may not be efficient is the basis of the second theory.

The theory states that, although they ultimately reflect fundamental values, irrational investors cause stock prices to substantially diverge from them in the short to medium term, hence mean reversion. The basic mechanism works as follows. If noise traders are optimistic about a stock, a sector or an asset class in general, its price will rise above fundamental value. If noise traders' fad does not revert and prices keep rising, other types of investors such as "feedback traders", "trend chasers" and "chartists" will buy the asset pushing its price even higher. In addition, as discussed by Schleifer and Vishny (1997), real life arbitragers concerned by the returns they are able to offer their customers for commercial reasons may not arbitrage the anomaly away as the financial theory suggests but to the contrary amplify it by jumping on the bandwagon. The combined effects of their actions is that, in the absence of traditional arbitrageurs to mitigate excesses, market prices may diverge substantially from fundamental prices for long periods of time (cf. De Long, Shleifer, Summers and Waldmann: 1990). *Shiller* (2000: 56) calls this mechanism "*naturally occurring Ponzi schemes*" because it feeds on the perception of prior success.

The trend starts to change due to the mean reverting nature of the market. Indeed, in such a market, investors develop expectations about the speed of the reversion. When an investor observes a positive change in a stock's return, his reaction will be different whether he expects the reversion to be close or distant in time. If he expects a quick reversion, the investor will sell the stock to realize the gain. On the other hand, if he expects the reversion to take place in a more distant future, he will hold onto the stock and perhaps increase its holding. The market trend changes when investors realize they misapprehended the speed of the mean regression. At this point, the most risk adverse investors who expect mean reversion to be close will sell first, followed by more risk prone investors as they realize the trend is changing. This is when the above mentioned

"feedback traders", "trend chasers" and "chartists" begin selling poorly performing stocks, thus amplifying the effects. Hillebrand (2003) describes how this mechanism might be responsible for stock-market crashes; in particular the October 1987 crack.

#### **2.4. Index rules and regression towards the mean**

The paper by Arora et al. (2008) is the backbone of this thesis. In their paper, the researchers show that stocks added to the Dow Jones Industrial Index underperform stocks deleted from the index. The authors theorise that financial markets exhibit mean regression, and therefore that companies exhibiting exceptionally low returns relative to their true ability for some time are bound to experiencing higher returns in the future whereas companies exhibiting exceptionally high returns relative to their true ability for some time are bound to experiencing lower returns in the future. *Citing Kahneman and Tversky (1974), they posit that regression to the mean is "often misunderstood or insufficiently appreciated"*. (Arora et al. 2008: 65.) Their logic implies that stock indexers are therefore bound to add companies that have performed above their ability to the index and delete companies that have performed below their ability from the index. Hence, they expect that deleted stocks will outperform added stocks as they regress to their true ability (Arora et al. 2008). However, in my opinion, their reasoning relies on an important underlying assumption which they fail to clearly mention or demonstrate. Indeed, they assume that steering committees in charge of stock indexes tend to drop poorly performing companies and add fast growing ones unconsciously. If this were not the case, the authors' conclusion about mean regression being the reason why stocks added to a blue chip index underperform stocks deleted from the same index would not hold.

The literature looking into exclusive stock indexes' rules and their influence on composition and performance is very sparse. In fact, there is to my knowledge only one paper which (indirectly) attended to look into what kind of stocks tend to be added to or



deleted from exclusive stock indexes. Rinaldo and Häberle's (2008) conclusions demonstrate that exclusive indexes' constitution and maintenance rules imply some active trading strategies based on stocks' past returns in many ways similar to momentum investment strategies. Their findings in effect contradict the assertion that stock index rebalancing is independent from stocks' past performances and, more importantly for my thesis, support the assumption that stock indexers tend to add "rising stars" to their index and drop "fallen angels". The first part of their paper compares the risk-adjusted performance of exclusive indexes with the performance of inclusive indexes. The authors find that exclusive indexes outperform inclusive indexes in upward markets. For instance, between 1990 and 2004, the CAC 40 total return was 51% during bull periods compared to 47.8% for the inclusive SBF 250 (250 largest market capitalisations on the Parisian exchange). They also find the opposite to be true; exclusive indexes underperform inclusive indexes in downward markets. Over the same period, the CAC 40 total return was -63% compared to -54.7% for the SBF 250. Rinaldo and Häberle (2008) find that exclusive indexes have a higher market beta which in turn is due to the active rebalancing of the index constituents. *The authors conclude "constitution and maintenance rules of exclusive indexes correspond to a set of active trading and investment rules similar to momentum strategies"*. (Rinaldo and Häberle 2008: 55.)

The lack of stability of stock indexes in risk exposure is confirmed by Amenc, Goltz and Le Sourd (2006). The researchers tested the stability of several indexes, among them the CAC 40, in terms of exposure to both investment styles and industry sectors and found that these vary drastically over time. Thus, stock indexes' performance is in essence state-dependant and variable over time which is at odds with the idea of a passive investment strategy.

The implications for my thesis of momentum in stock prices followed by regression towards their true ability in addition to the fact that index rules are biased towards adding stocks that have performed well in the recent past and deleting stocks that have performed poorly in the recent past, should lead to stocks added to an exclusive index underperforming those deleted.

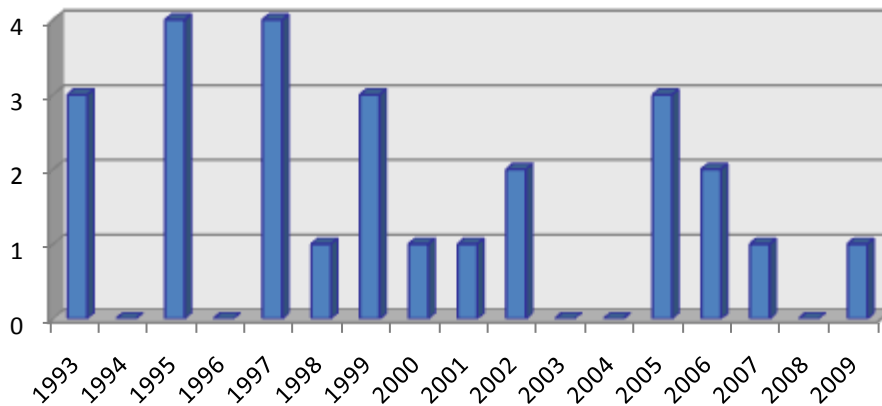
### 3. DATA AND METHODOLOGY

The approach I follow in order to answer the research question is two-fold and partly based on the paper by Arora et al. (2008). In a first stage, the authors, using a buy-and-hold strategy, calculate the average daily returns for two portfolios; one composed of stocks added to and one composed of stocks deleted from the Dow Jones Industrial index. They, then, took on to test if the difference in returns was due to higher undertaken risk. In a second stage, the authors compare deleted and added stocks' average performance at regular intervals after substitution is announced. In addition to that, I feel that calculating abnormal returns (compared to the benchmark index) could add value to the results. Another difference is that I chose not to take account of the daily returns on the stocks being replaced for the following 10 trading days after the announcement is made. I aim to adjust for well known abnormal market activities surrounding stock replacements as passive mutual fund managers readjust their holdings and speculators try to anticipate and take advantage of it.

#### 3.1. Data

This thesis is based on the CAC 40 index; the main benchmark for the Parisian bourse. It tracks a sample of 40 blue chip companies thought to be representative of the Parisian equity market and selected among the top 100 market capitalisation and most active stocks listed on Euronext Paris. This list is publicly available on Euronext's website which is said to help investors anticipate the index's rebalancing. The index's base value of 1,000 was set on 31 December 1987. Its all-time high at 6,922.33 points was reached at the peak of the dot-com bubble in September 2000. Since December 1<sup>st</sup>, 2003, the index's weighting system is based on free-float adjusted market capitalisation. The maximum weight of any particular stock in the index cannot exceed 15%. The CAC 40 is one of the main national stock indexes that merged in 2000 to form the pan-European

stock exchange group Euronext; the world's fourth largest stock market by market value in 2009. The “Conseil Scientifique” is the index steering committee responsible for setting the rules and the periodical selection. The index's composition is reviewed every quarter though changes do not occur each time. If changes are decided, there is a minimum of two weeks between the review meeting and the actual index rebalancing. Also changes are always announced after the stock market closes on the meeting day. Figure 5 below shows the number of annual clean changes in the CAC 40 index over the period 1993 – 2009.



**Figure 5.** Number of annual changes in the CAC 40 index.

Two portfolios are formed; one including all clean additions and the other including all clean deletions that occurred on the CAC 40 index between 1993 and 2009. *In accordance with Arora et al. (2008: 66), I use only clean changes and therefore ignore those that were due to mergers, acquisitions, or name changes that did not involve the addition of one stock and deletion of another.* In other words, only changes initiated and decided by the Steering committee and not forced upon it form one or the other portfolio.

Between 1993 and 2009, there have been a total of 25 clean changes made on the CAC 40 index. I could not find any historical price regarding “Chargeur”; a company that was deleted from the index in 1993 and split off three years later. The first addition to the

portfolios took place on November 4th, 1993 and terminal wealth is as of December 31<sup>st</sup>, 2009. The study covers 4,095 trading days.

The historical price database available on the NYSE Euronext website allows me to track daily returns on the Parisian stock index for companies that are still currently listed as well as the stock indexers' rebalancing decisions back to August 2005. To collect historical daily returns on companies that are no longer listed and rebalancing decisions prior to August 2005, I have to use the online archives of one of the most authoritative French financial newspapers "Les Echos".

Finally, the Euribor 3-Month is used to calculate the Sharpe and Treynor ratios and hence determine the portfolios risk-adjusted performance. The French Pibor-3 month is used for the period prior to the launch of the European interbank offer rate on December 28<sup>th</sup> 1998. The data was provided by the University of Vaasa.

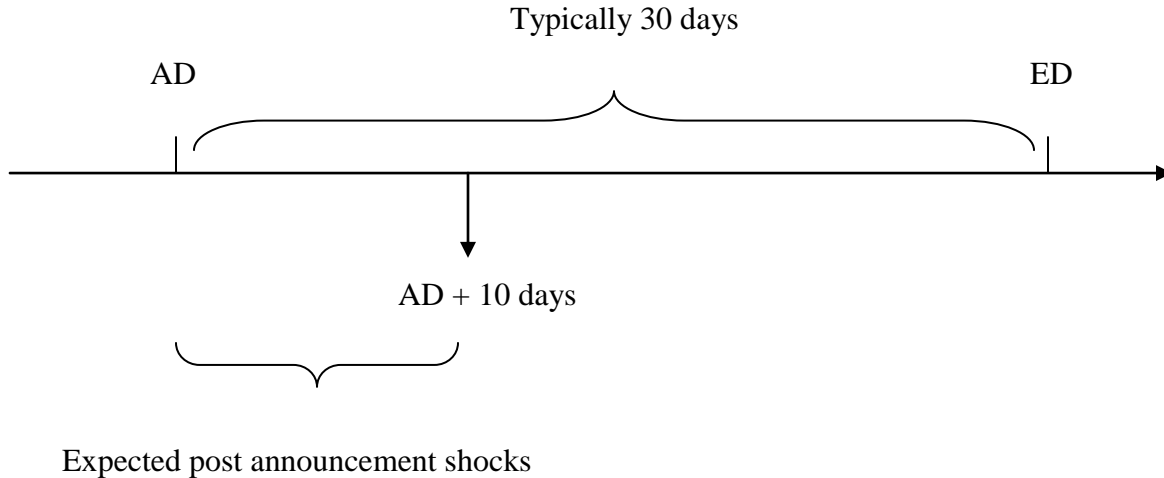
## **3.2. Methodology**

### **3.2.1. Construction of the portfolios**

I endeavour to answer the research question using two different methodologies. In the first, the funds are invested equally in each of the stocks at the beginning of the study period and then after each index rebalancing. For instance (see appendix 1), one third of the funds are invested in each of the three replaced stock at the beginning of the study period (October 19<sup>th</sup>, 1993) followed by one sixth in each of the six stocks replaced after the second index rebalancing (January 11<sup>th</sup>, 1994), and so on.... The stocks are added to their respective portfolio ten trading days after the replacement was officially announced in order to adjust for known temporary abnormal market activities surrounding stock's replacements in the CAC 40 index and other indexes. I follow a buy-and-hold strategy

and keep the stocks in the portfolios until the end of the study period without short selling the added stocks.

Addition and deletion timetable:



AD: Announcement date of the change (after stock market closes).

ED: Date when the change takes place.

AD + 10 days: Stocks are added to their respective portfolios 10 trading days after the announcement is made.

In the second approach, I look at the average daily performance of all added and deleted stocks at regular intervals over a period of five trading years beginning ten trading days after the replacement was officially announced. The delay is to adjust for known temporary abnormal market activities surrounding stock's replacements in the CAC 40 index.

If a stock that had been previously deleted from the CAC 40 is once again included in it, it moves from the deletion portfolio to the addition portfolio. Following the same logic, if a stock that is in the addition portfolio is deleted from the CAC 40, it moves back from the addition portfolio to the deletion portfolio. In this particular case and although

evidence of pre announcement abnormal price and volume activities have been found in the days preceding a stock's addition to or deletion from an index, I decided not to exclude any daily return prior to the announcement date to ensure that investors are able to base their investment strategy on my findings.

### **3.2.2. Portfolios performance**

#### **3.2.2.1. Stock returns**

The fact that I need to aggregate individual stocks' daily return to calculate the portfolio's return makes the use of arithmetic returns more appropriate.

The return on an individual stock is given by:

$$(5) \quad r_{i,t} = \left( \frac{p_{i,t}}{p_{i,t-1}} \right) - 1$$

With

$P_{i;t}$  = Price of stock i at time t

$P_{i;t-1}$  = Price of stock i at time t-1

#### **3.2.2.2. Portfolio returns**

Since the portfolios are equally weighted, the return on day t is given by averaging the arithmetic returns of the stocks which constitute them and are given by:

$$(6) \quad r_{p,t} = \frac{1}{I} \sum_{i=1}^I r_{i,t}$$

With:

$I$  = Number of stocks in the portfolio

$r_{i,t}$  = Return on stock  $i$  at time  $t$

The daily returns are then multiplied to calculate the cumulative returns and the final wealth:

$$(7) \quad r_T = \prod_{t=1}^T (1 + r_{p,t}) - 1$$

With:

$r_{p,t}$  = Return on the portfolio at time  $t$

### 3.2.2.3. Portfolio adjusted returns

Another way of assessing the portfolios' performance is to calculate their return in excess of the market as a whole. The cumulative adjusted return strategy was not part of Arora et al.'s (2008) paper but I believe this adds interesting results and later studies could be based on adjusted returns instead of “normal” returns.

The first step is to calculate the portfolios' daily benchmark-adjusted returns:

$$(8) \quad ar_{p,t} = r_{p,t} - r_{m,t}$$

With:

$r_{p,t}$  = Return on the portfolio at time  $t$  as calculated in formulas (1) and (2)

$r_{m,t}$  = Return on the CAC 40 index

The daily adjusted returns are then multiplied to calculate the cumulative adjusted returns:

$$(9) \quad car_T = \prod_{t=1}^T (1 + ar_{p,t}) - 1$$

With:

$ar_{p,t}$  = Adjusted return on the portfolio at time t

#### 3.2.2.4. Statistical significance

To assess the statistical difference in returns between the two portfolios, a matched-pair t-test is performed using the daily difference between the returns on the Deletion portfolio and the Addition portfolio. The null hypothesis is that the expected value of the difference in each day's return should be zero. The t-statistic shows how much or how little the null hypothesis is supported by the data. It is calculated as follow:

$$(10) \quad t = \frac{\bar{X} - 0}{s / \sqrt{n}}$$

With:

$\bar{X}$  = Mean of daily differences

s = Standard deviation of the daily differences

n = Number of daily differences

#### 3.2.3. Measure of risk

Given that assets or portfolios with greater risks have higher expected returns, it is crucial to compare portfolios not only on their returns but also on the risk undertaken when investing in one of them. Researchers in the 1960's have started to address this problem



and developed several measurement tools that look at both returns and risk to evaluate portfolios' performances. They are called risk-adjustment performance metrics (RAPM) and are typically based on the central Capital Asset Pricing Model (CAPM) developed by Treynor (1962), Sharpe (1964) and Lintner (1965). The CAPM addresses the problem of adjusting returns given a portfolio's risk. The model states that the expected return of a security or a portfolio equals the rate of return on a risk-free security plus a risk premium.

The Treynor ratio (also known as the Reward-to-Volatility-Ratio) was the first to provide investors with a composite measure of portfolio performance that also included risk. It was developed by J. L. Treynor in the early 60's and measures the returns earned in excess of those that could have been earned on a riskless investment per unit of market risk.

$$(11) \quad S = \frac{r_p - r_f}{\beta}$$

where  $r_p$  is the return of the portfolio,  $r_f$  is the risk free rate of interest (such as the Euribor 3 Months) and  $\beta$  the volatility of the portfolio.

The Sharpe ratio (or Reward-to-Variability Ratio) is almost identical to the Treynor ratio except that the risk measure is the standard deviation of the portfolio instead of considering the systematic risk, represented by beta:

$$(12) \quad S = \frac{r_p - r_f}{\sigma}$$

where  $r_p$  is the return of the portfolio,  $r_f$  is the risk free rate of interest (in this thesis the Euribor 3 Months) and  $\sigma$  is the standard deviation of the portfolio's excess return.

The greater a portfolio's Treynor or Sharpe ratio, the better its risk-adjusted performance has been.

## **4. EMPIRICAL RESULTS**

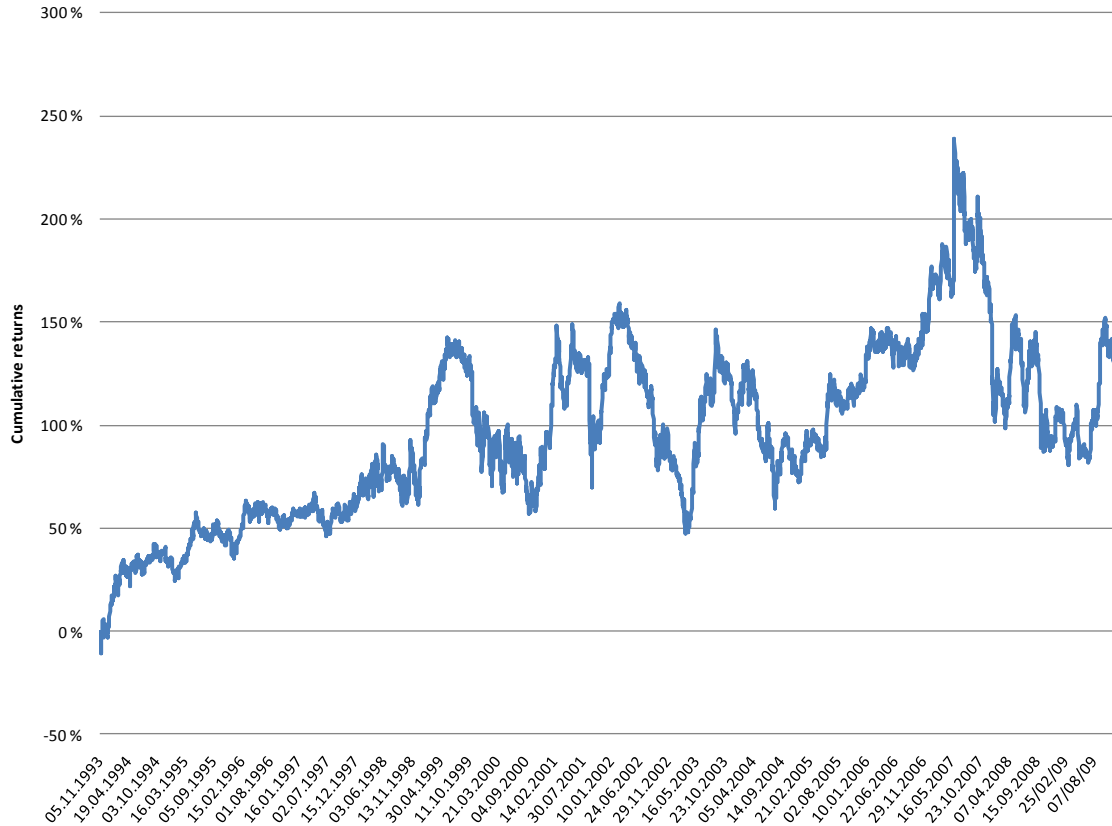
### **4.1. Portfolios' and index historical performance**

Figure 6 shows the cumulative returns on both the Deletion and Addition portfolios as well as on the CAC 40 index over the 16 years to 2009. The Deletion portfolio has the highest terminal value as of December 31<sup>st</sup> 2009 followed by the Parisian index and finally the Addition portfolio. The cumulative returns of the Deletion portfolio (represented by the red line) remain at any point in time higher than the performance of both the index (represented by the blue line) and the Addition portfolio (represented by the green line). Without accounting for risk, the Addition portfolio clearly underperformed both the CAC 40 index and the Deletion portfolio.



**Figure 6.** Cumulative returns in percent on both portfolios and the CAC 40 index between 1993 and 2009.

Figure 7 shows the difference in cumulative returns between the Deletion and the Addition portfolios over the period 1993 – 2009. The trend is clearly positive and steadily increasing which indicates that the Deletion portfolio outperforms the Addition portfolio for most of the period considered. The financial crises of the early 2000s and of 2007 show to be the exceptions with the difference in returns between the two portfolios being more volatile.



**Figure 7.** Difference in portfolios' cumulative returns (Deletion minus Addition) between 1993 and 2009.

## 4.2. Comparison of the portfolios' returns

### 4.2.1. Portfolios' arithmetic returns

Table 1 summarises the daily returns for the Deletion and Addition portfolios over the period 1993 – 2009. The portfolio formed of stocks removed from the index had an average daily return of 0.038% compared to 0.025% for the Addition portfolio. Assuming 250 trading days per year, this translates into an average annual return of 9.87% for the Deletion portfolio and 6.54% for the Addition portfolio. Consistent with my hypotheses

H<sub>1</sub> to H<sub>4</sub>, stocks deleted from the CAC 40 index between 1993 and 2009 outperformed the stocks that replaced them by an average of 0.013% every day or 3.3% per year.

**Table 1.** Summary statistics of the Deletion and Addition portfolios' daily returns over the period 1993 – 2009.

	<b>Deletion Portfolio</b>	<b>Addition Portfolio</b>
<b>Average daily return (%)</b>	0.038	0.025
<b>Difference in mean (2-tailed)</b>		0.544
<b>Minimum (%)</b>	-8.99	-9.47
<b>Maximum (%)</b>	10.58	12.72
<b>Std. Deviation</b>	0.014	0.016
<b>Skewness</b>	0.128	0.215
<b>Kurtosis</b>	3.55	4.461
<b>Terminal wealth (for €1 invested as of December 31st, 2009)</b>	€3.10	€1.71
<b>Sharpe ratio</b>	2.7	1.7
<b>Treynor ratio</b>	0.06	0.03

The kurtoses are 3.55 and 4.46 indicating distributions rather clustered in the centre around the mean while the tails are relatively flat. The positive skewness for both portfolios in turn indicates scores clustered to the left at the low values. The table also shows that €1 invested in the Deletion portfolio in 1993 would have been worth €3.10 on December 31st, 2009 whereas €1 invested in the Addition portfolio would have been worth only €1.71. Furthermore, the higher returns are not due to some sort of risk premium. Indeed, both the Sharpe and the Treynor ratios are higher for the Deletion portfolio than for the Addition portfolio which indicates that the risk adjusted performance of the former is higher than that of the latter. Nevertheless, the t-test score indicates that the results cannot be generalised. This might be due to the period covered in my thesis being too short. Indeed, the most directly comparable studies use much

longer time-series. Arora et al. (2008) study the Dow Jones Industrial Index since its launch in 1928, Siegel and Schwartz (2006) use the S&P 500 since 1957 and finally Cai and Houge (2008) look at the Russel 2000 since 1979.

Table 2 shows that the portfolio formed of stocks deleted from the index had an average daily return of 0.038% compared to 0.019% for the Addition minus IPOs portfolio. Consistent with my hypotheses  $H_1$  to  $H_4$ , stocks deleted from the CAC 40 index between 1993 and 2009 outperformed the stocks that were added to the index by an average of 0.019% every day. Furthermore, it seems that the higher returns are not due to some sort of risk premium since the risk adjusted performance as measured by the Sharpe and the Treynor ratios is higher for the Deletion portfolio than for the Addition minus IPOs portfolio. Nevertheless, the t-test score again indicates that the results cannot be generalised.

**Table 2.** Summary statistics of the Deletion and Addition minus IPOs portfolios' daily returns over the period 1993 – 2009.

	<b>Deletion Portfolio</b>	<b>Addition minus IPOs portfolio</b>
<b>Average daily return (%)</b>	0.038	0.019
<b>Difference in mean (2-tailed)</b>		0.38
<b>Minimum (%)</b>	-8.99	-10.37
<b>Maximum (%)</b>	10.58	11.42
<b>Std. Deviation</b>	0.014	0.016
<b>Skewness</b>	0.128	0.135
<b>Kurtosis</b>	3.55	4.329
<b>Terminal wealth (for €1 invested as of December 31st, 2009)</b>	€3.10	€1.31
<b>Sharpe ratio</b>	2.7	1.2

<b>Treynor ratio</b>	0.06	0.02
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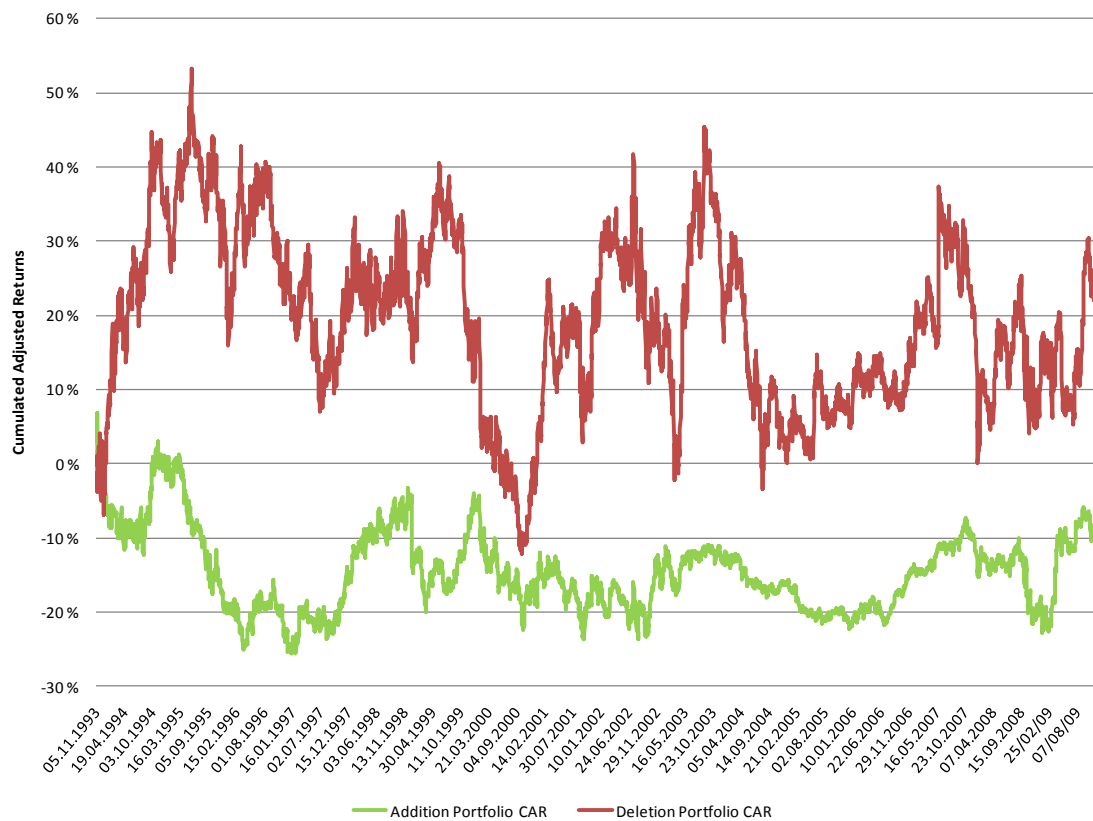
Substantial evidence collected from various markets across the world has shown that IPOs traditionally exhibit three patterns: under pricing, "hot issue" markets (periods of high average initial returns and rising volume) and poor long term performances. As a result, stocks added to the index following the first floatation of their shares may lower the performance of the Addition portfolio. However, in contradiction with the general consensus on IPOs' long term performance including French studies (cf. Leleux: 1993) and my hypothesis H<sub>6</sub>, I did not find that IPO companies underperform other additions to the CAC 40 index. In fact, not only did the Addition portfolio perform better with the IPO companies than without (0.025% Vs. 0.019% per day) but the IPO companies also outperformed the CAC 40 index (0.041% Vs. 0.026% per day). When looking at the Sharpe and Treynor ratios, IPO companies in fact improve the portfolio's risk adjusted performance (1.7 Vs. 1.2 for the Sharpe and 0.03 Vs. 0.02 for the Treynor ratio).

The explanation might lay in the nature of the five IPO companies that were added to the index between 1993 and 2009. IPO companies were in fact among the country's largest and most established companies before they were privatized by successive governments. A wave of privatization of large public companies started in 1993 with what is now one of Europe's largest bank, BNP Paribas. The privatization of car manufacturer Renault followed suit in 1995. The other three IPOs consist of utility companies who experienced a monopolistic position before their respective markets had to be open to competition in order to comply with EU regulations and their shares sold to the public. The three companies are France Telecom, Europe's third largest telecommunication company privatized in 1997, GDF and EDF which are respectively among the world's largest gas and electricity utility companies and were privatized in 2005. Telecoms and utilities are known by investors for having steady returns and low volatility which may explain why they did not underperform as IPO companies tend to.

Given that the Addition portfolio including the IPO companies exhibits a better performance than without the IPO companies, from here on I will only consider the Addition portfolio including the IPO companies.

#### 4.2.2. Portfolios' market adjusted returns

Figure 8 shows the cumulative market adjusted returns on both Deletion and Addition portfolios between 1993 and 2009. The Deletion portfolio (represented by the red line) has the highest terminal value as of December 31<sup>st</sup> 2009. However, this seems to come at the price of a much higher variability in returns.



**Figure 8.** Cumulative adjusted returns in percent on both portfolios between 1993 and 2009.



Table 3 summarises the daily returns for the Deletion and Addition portfolios over the period 1993 – 2009 adjusted for market returns. The portfolio formed of stocks removed from the index had an average adjusted daily return of 0.012% or 3.07% annually compared to an average adjusted daily loss of (0.0002)% or (0.06%) annually for the Addition portfolio. Furthermore, the Deletion portfolio yielded 21.5% abnormal return at the end of the 16 years of the study period whereas the Addition portfolio suffered a loss of 9.1%. It also shows that the Deletion portfolio not only outperformed the Addition portfolio but also the CAC 40 index. To the contrary, the Addition portfolio underperformed the index over the period of time and therefore dragged down its overall performance. Nevertheless, the t-test score again indicates that the results cannot be generalised. Since the Addition portfolio exhibits negative returns unlike the Deletion portfolio, measures of risk reward ratios such as the Sharpe and Treynor ratios seem to be irrelevant.

**Table 3.** Summary statistics of the daily market adjusted returns for the Deletion and Addition portfolios over the period 1993 – 2009.

	<b>Deletion Portfolio</b>	<b>Addition Portfolio</b>
<b>Average adjusted daily return (%)</b>	0.012	(0.0002)
<b>Difference in mean (2-tailed)</b>		0.544
<b>Minimum (%)</b>	-5.3	-9.3
<b>Maximum (%)</b>	8.3	4.1
<b>Std. Deviation</b>	0.012	0.006
<b>Skewness</b>	0.05	(0.649)
<b>Kurtosis</b>	2.094	12
<b>CAR as of December 31st, 2009</b>	0.215	(0.091)

### 4.3. Substituted stocks' behavior after substitution

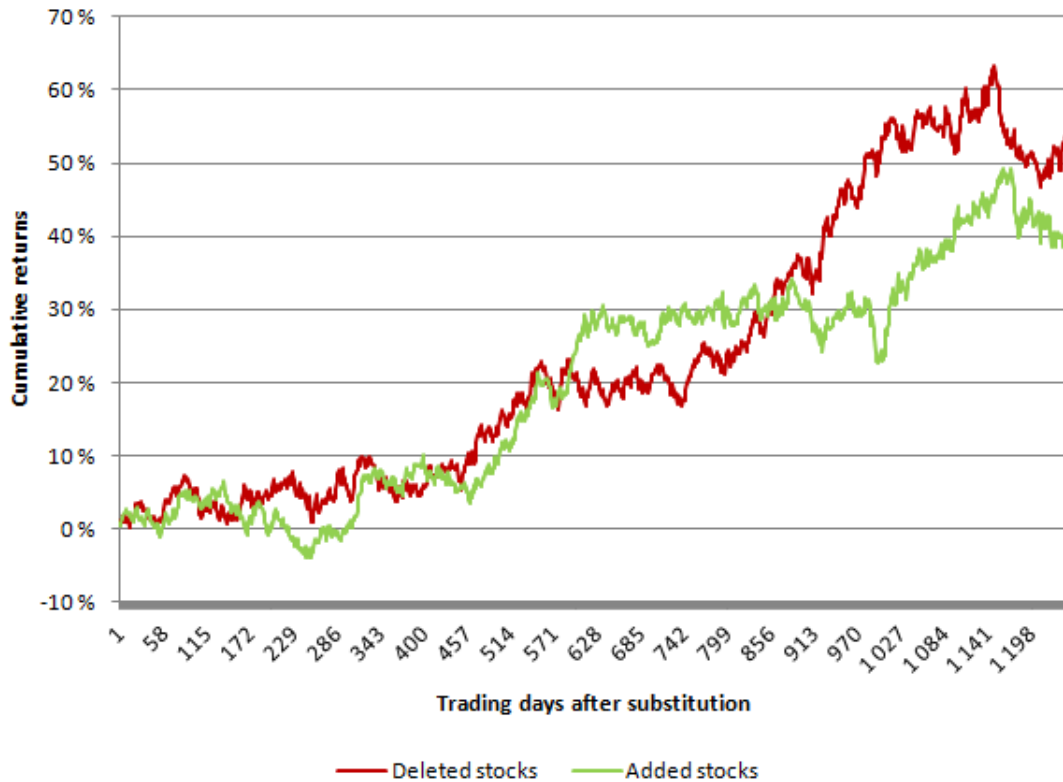
Another way to study whether stocks added to the CAC 40 index outperform those they replace is to look at their average returns at different intervals after replacement was announced. Thus, I look at the daily returns for each deleted or added stock starting ten trading days after the announcement was made in order to adjust for known temporary abnormal market activities surrounding the stocks' replacements in the CAC 40. The added and deleted stocks' daily and cumulative returns are then averaged and compared.

Table 4 shows the average daily performance of all substituted stocks' at 250-trading-day intervals (a calendar year) over the first five years after replacement was announced. Over the first 250 trading days, deleted stocks clearly outperform added stocks. Indeed, deleted stocks yield 0.018% per day while added stocks lose (0.01)% per day over the same period. Furthermore, deleted stocks show to be slightly less volatile as measured by the standard deviation of their average returns. Over the four following years however, added stocks outperform deleted stocks three times. Considering 250-day intervals, the results indicate that added stocks' relative underperformance compared to deleted stocks does not last beyond the first trading year after replacement. However, volatility as measured by standard deviation tend to be greater for added stocks than for deleted stocks.

**Table 4.** Stocks' average daily returns for different horizons after substitution date.

<b>Year</b>	<b>Day</b>	<b>Deletions (%)</b>	<b>Std. Deviation</b>	<b>Additions (%)</b>	<b>Std. Deviation</b>
<b>1</b>	250	0.018	0.018	(0.01)	0.022
<b>2</b>	500	0.041	0.03	0.053	0.035
<b>3</b>	750	0.022	0.02	0.062	0.059
<b>4</b>	1,000	0.091	0.093	(0.014)	0.02
<b>5</b>	1,250	0.008	0.033	0.04	0.054

Figure 9 illustrates the cumulative returns for deleted and added stocks after substitution announcement. It shows that deleted stocks clearly outperform added stocks five years after replacement was announced. The graph also shows that around year three, added stocks have a higher terminal value than deleted stocks. Finally, the graph shows that deleted stocks perform extremely well compared to added stocks during the fourth year after substitution was announced.



**Figure 9.** Substituted stocks' cumulative returns over 5 trading years.

Table 5 shows added and deleted stocks' cumulative returns at 250-day intervals (a calendar year) over the first five years after replacement was announced. The average level of wealth is higher for the deletion portfolio in all but one of the five considered years. The added stocks in fact lose value during the first year after replacement was announced contrary to deleted stocks. After five years, deleted stocks' value increased by

an average of 53.5% while added stocks increased by an average of 35.9%. Year three is the only year when added stocks' terminal value is higher than that of the deleted stocks.

**Table 5.** Stocks' cumulative returns for different horizons after substitution date.

<b>Year</b>	<b>Day</b>	<b>Deletions</b>	<b>Additions</b>
<b>1</b>	250	1.041	0.9731
<b>2</b>	500	1.149	1.107
<b>3</b>	750	1.209	1.288
<b>4</b>	1,000	1.511	1.237
<b>5</b>	1,250	1.535	1.359

## 5. SUMMARY AND CONCLUSIONS

Increasingly popular passive investment strategies simply replicate the performance of their benchmark stock index. However, stock indexes' composition is reviewed and revised at regular intervals (quarterly for the CAC 40 index). In the specific case of exclusive indexes, the composition is left to the discretion of steering committees. It is therefore important for passive investors to gain an understanding of the impact of the committees' decisions on the performance of their portfolio as well as for other investors to anticipate how substituted stocks are likely to perform after they are added to or removed from an exclusive index. Interestingly, while the days and weeks surrounding stocks' addition to or removal from an index have been thoroughly documented, long term analyses of their performance following substitution are scarce. This thesis is one of the few attempts to look into the matter.

This paper investigates whether stocks deleted from the French CAC 40 index outperformed stocks added to the index between 1993 and 2009. As a first attempt to understand stocks' behaviour after addition to or removal from the index, I compare the performance of a portfolio composed of stocks deleted from the index with the performance of a portfolio composed of stocks added to the index. I find that the portfolio composed of stocks deleted from the index outperforms the portfolio composed of stocks added to the index by 0.013% on average each day. Furthermore, the results indicate that the deletion portfolio's performance is not due to higher risk. In addition, the excess returns do not require short sales and do not incur large transaction costs. However, the results cannot be generalised perhaps due to too short a time-series.

In a second phase, I analyse the average return at different intervals of all added and deleted stocks. I find that deleted stocks clearly outperformed added stocks over the first 250 trading days after substitution is announced. Indeed, deleted stocks yielded 0.018% per day while added stocks lost (0.01)% per day over the same period. Looking at cumulative returns, deleted stocks showed an average increase in value of 4.1%

compared to an average loss of 2.69% for added stocks one year after substitution was announced. Over five years, deleted stocks yielded 53.5% while added stocks yielded only 35.9%.

I mainly attribute these findings to two mutually supportive factors. First, index rules favour the addition of stocks which have performed well in the recent past and the removal of stocks which have performed poorly in the recent past. Second, as the phenomenon of mean regression in stock prices slowly takes its toll, stocks that have been performing exceptionally well in the recent past (such as those added to exclusive blue-chip stock indexes) are bound to lower performance in the future as their performance regresses to their long term trend. To the contrary, stocks which have been performing exceptionally poorly in the recent past (such as those removed from exclusive blue-chip stock indexes) are bound to higher performance in the future as their performance regress to their long term trend. Interestingly, just like the debate about mean regression in stock prices is still not closed, my results cannot be generalised. However, I believe this paper is valuable to contrarian investors who could take advantage of my findings to buy equities after they have been deleted from an exclusive index and by short selling stocks after they have been added to an exclusive index. The findings could also improve stock indexes' rules by pointing at certain biased rules.

Considering the small amount of research on the topic and given that following a similar methodology has led to different results, additional analyses on the long term behavior of substituted stocks should be conducted. Unlike mine, Arora et al.'s results (2008) were statistically significant; therefore research could be done based on other exclusive indexes. In the same vein, researchers could look at different index types such as small or mid cap indexes for instance. Yet again, researchers could use the CAC 40 index on which this thesis was based and extend the study period perhaps going as far back as 1987 when the index was launched. Indeed, too short a time series may explain why my results are not statistically significant. The most directly comparable papers analyse much longer periods and hence have many more observations and clean changes to account for. Arora et al. (2008) study the Dow Jones Industrial Index since its launch in 1928, Siegel

and Schwartz (2006) use the S&P 500 since 1957 and Cai and Houge (2008) look at the Russel 2000 since 1979. In a similar fashion to Siegel and Schwartz (2006), researchers could replicate an original index as it was when first launched and track its performance had there been no rebalancing. Finally, on a different but related topic, further research should be conducted looking into the characteristics and the recent past performance of the stocks newly added to or removed from exclusive indexes. The results may highlight some bias in stock index rules and hence help steering committees correct them.

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## APPENDIX 1. List of "clean" changes on the CAC 40 between 1993 and 2009

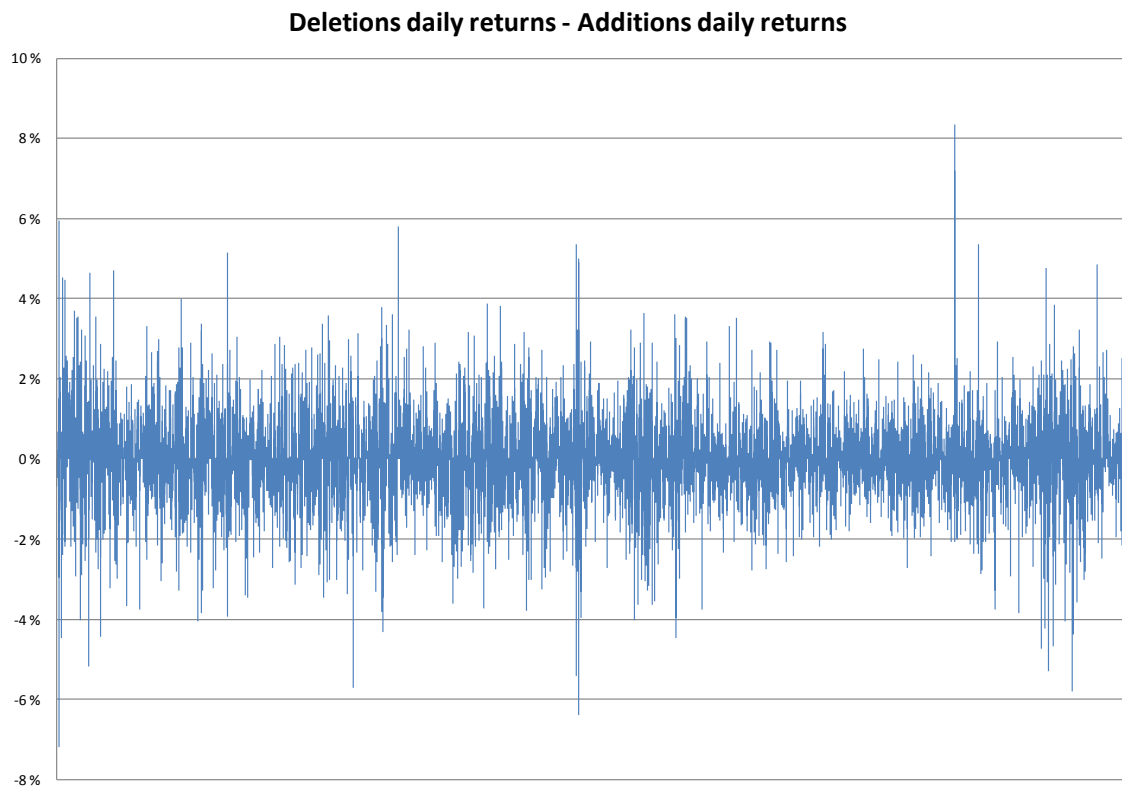
Date of Announcement	Additions	Deletions
1993		
October 19 <sup>th</sup>	BNP	Cap Gemini
	Crédit Local de France	Chargeurs*
	Promodès	Club Méditerranée
1995		
January 11 <sup>th</sup>	Eurotunnel	Casino Guichard-Perrachon
	Pinault-Printemps-Redoute	CGIP
	Renault	Euro-Disney
October 11 <sup>th</sup>	Eridania Beghin Say	Crédit Foncier de France
1997		
January 27 <sup>th</sup>	Valeo	Saint-Louis
September 22 <sup>nd</sup>	France Telecom	Bouygues
	ST MicroElectronics	Pernod-Ricard
1998		
April 24 <sup>th</sup>	Sodexho-Alliance	Havas Advertising
1999		
February 1 <sup>st</sup>	Casino-Guichard	Usinor
June 18 <sup>th</sup>	Equant	Bic
October 1 <sup>st</sup>	Bouygues	Eridania Beghin Say
2000		
May 10 <sup>th</sup>	TF1	Legrand
2001		
July 11 <sup>th</sup>	Vivendi Environnement	Valéo
2002		
March 1 <sup>st</sup>	Vinci	Alstom
July 9 <sup>th</sup>	Crédit Agricole	Dassault Systèmes
2004		



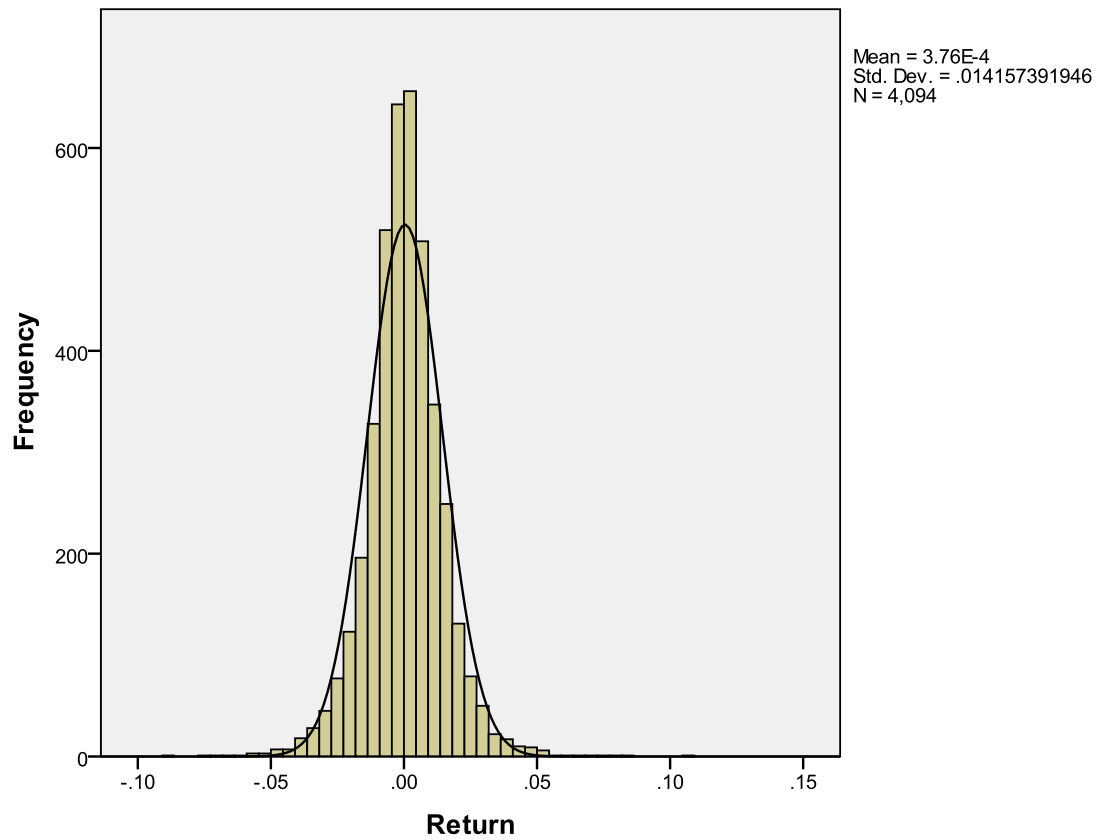
<b>December 20<sup>th</sup></b> 2005	Essilor International	Sodexho Alliance
<b>August 4<sup>th</sup></b>	Gaz de France	Casino Guichard
<b>November 24<sup>th</sup></b>	EDF	TF1
2006		
<b>June 23<sup>rd</sup></b>	Alstom	Thales
<b>November 24<sup>th</sup></b>	Vallourec	Publicis
2007		
<b>May 29<sup>th</sup></b>	Air France-KLM	Thomson
2009		
<b>September 4<sup>th</sup></b>	Technip	Air France-KLM
<hr/>		
<b>Number of Replacements</b>	<b>25</b>	<b>25</b>

\*: No data available

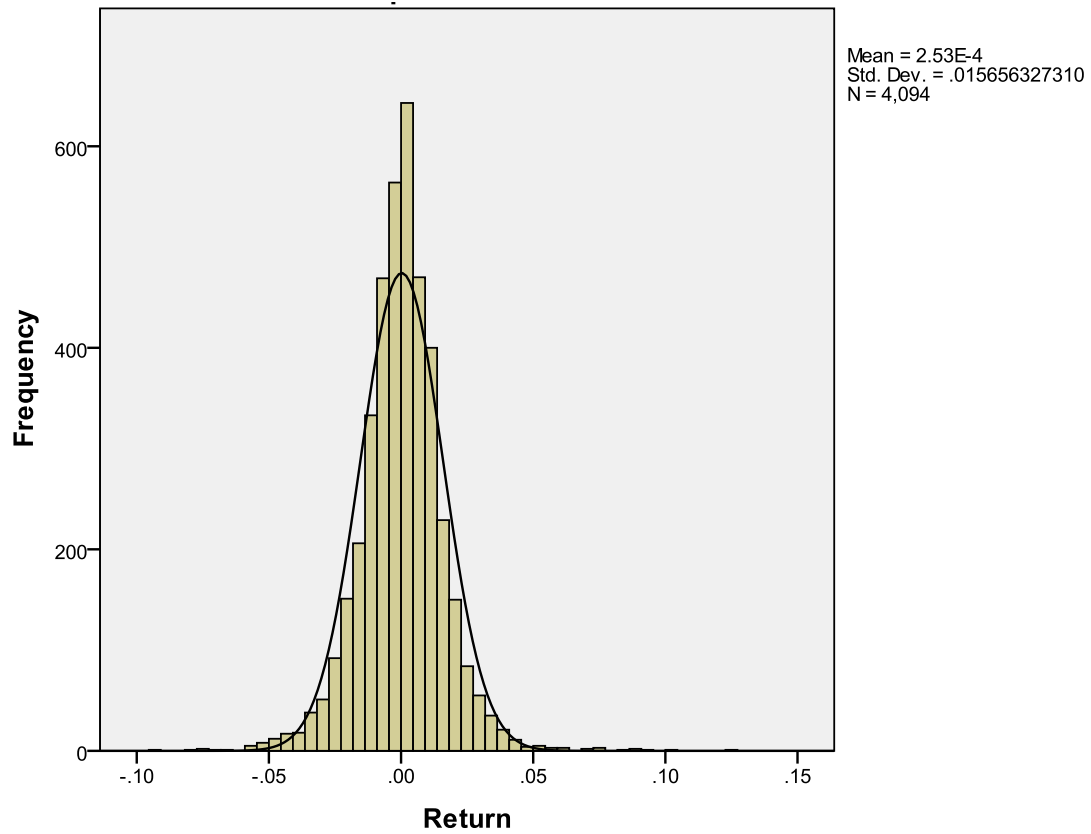
## APPENDIX 2. Difference in daily returns



### APPENDIX 3. Histogram of the portfolios' daily returns



Histogram of the deletion portfolio's daily returns.



Histogram of the addition portfolio's daily returns.